• PINS •

Portable Isotopic Neutron-Spectroscopy Chemical Assay System

"Created in response to the growing worldwide need to determine *in situ* the specific nature of the contents of an assortment of containers of munitions and chemical weapons"

- **Non-destructive Chemical Assay tool**
- **Identifies contents of munitions and chemical-storage containers safely and reliably by use of special fingerprinting algorithms**
- **Portable**
- **Easy to use**
- **Rugged enough for military or civil defense use**
- **Assay times: 100 to 1000 seconds**

EG&G ORTEC

Introduction

The PINS Chemical Assay System was created in response to the growing worldwide need to determine *in situ* the specific nature of the contents of an assortment of containers of munitions and chemical weapons. PINS is a joint development of EG&G ORTEC and the INEL Idaho National Engineering Laboratory.*

Such applications **require** portability, reliability, and ease of use. The performance of PINS, available from EG&G ORTEC, has been verified in real-world use by the U.S. Army, which has successfully identified, in the field, hundreds of suspect munitions from burial sites and firing ranges. PINS readily and clearly distinguished between cylinders containing high explosives, ones that contains blister agents, and ones filled with nerve gas.

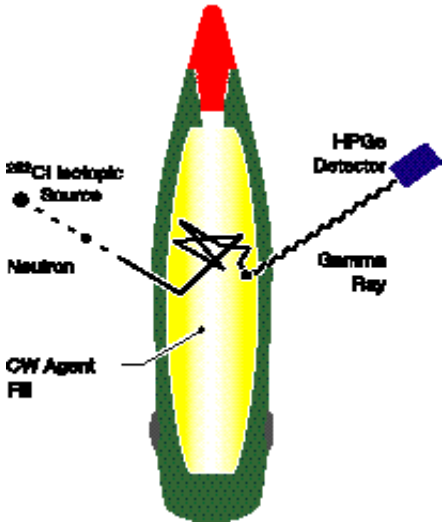
Recent international events have demonstrated the value of having such an instrument in the fight against terrorism.

PINS is being evaluated as a method for measurements enunciated under the CWC Chemical Weapons Convention, currently being ratified worldwide.

*CRADA93-ST-12.

Principle of Operation

PINS is a novel application of a well-understood technique, involving the interrogation of a container, using neutrons from a small moderated source. The neutrons pass through the wall of the container and collide with the atomic nuclei of the contents. The ensuing nuclear reactions ("neutron capture" and "inelastic scattering") produce gamma rays, which when appropriately detected and recorded, produce a gamma-ray spectrum (see facing page). The gamma-ray spectrum peaks are found at channel numbers (horizontal axis) corresponding to energies associated with specific nuclear deexcitations characteristic of the chemical element concerned. The relative heights of the peaks are related to the ratios of the elements inside the container.



These energies and ratios are in themselves UNIQUELY characteristic of the contents of the container, whether high explosive, nerve gas, or other.

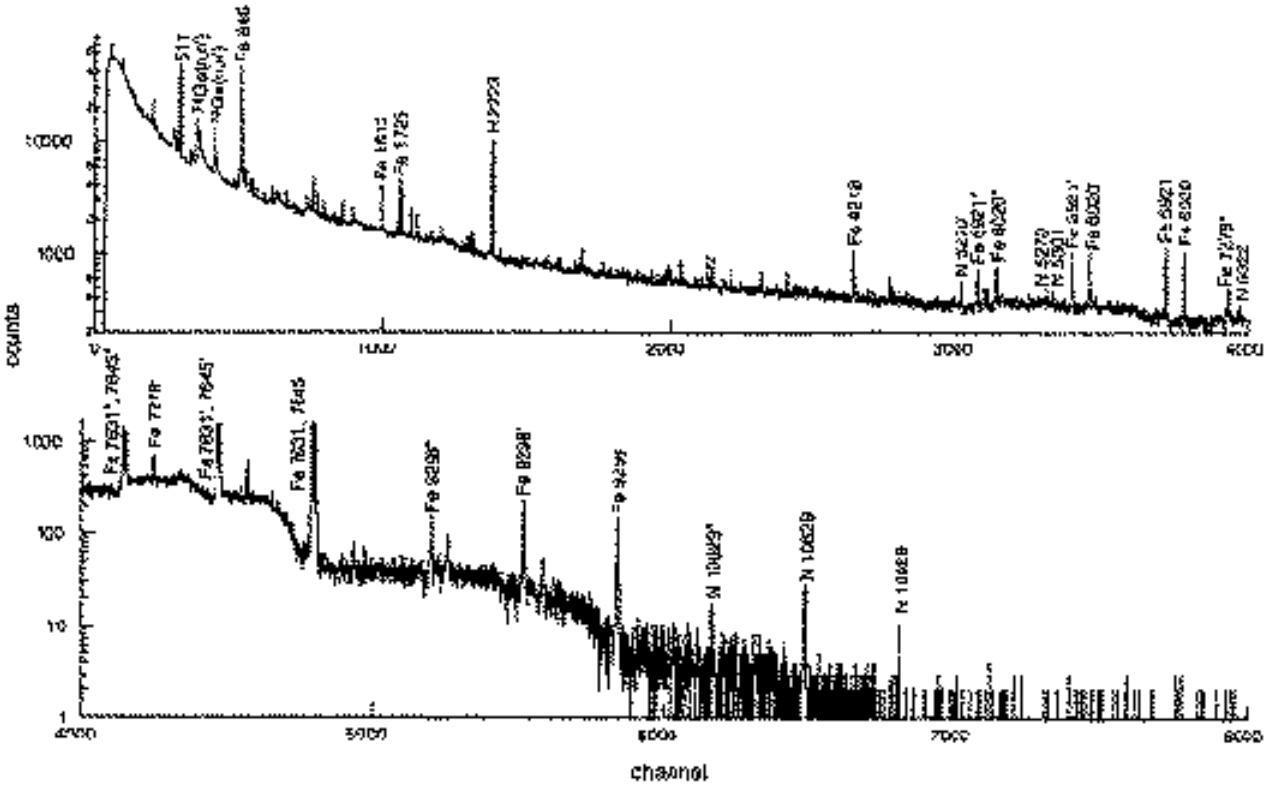
In this way, with a "library" of known signatures, it is possible to determine unambiguously the contents of the container.

Scope of Effectivity

PINS has been demonstrated effective in the identification of:

- Chemical Weapons including nerve agents GA, GB (sarin), and VX
- Blister Agents HD, HN, HT (mustard gases), and Lewisite
- High Explosives of composition B, RDX, and TNT

PINS can also identify containers filled with military screening smokes, such as titanium tetrachloride (FM) and White phosphorus (WP). It can also identify practice munitions filled with water, concrete, or sand.



High Explosive Gamma-Ray Spectrum.

PINS In Use

PINS MCA Emulation software is used for spectrum acquisition. After the spectrum is collected and stored, the PINS Analysis software analyzes the spectrum to determine the container's contents.

PINS has been successfully used to analyze both munitions and suspicious containers. A partial listing is given in Table 1.

Table 1. Summary of PINS Real-World Assays.†

Date	Location	Suspect Items	Results
May 1992	Anniston Army Depot, AL	18 4.2-inch mortar projectiles 1 55-gallon drum	No key elements found which could indicate high explosives or blister agents; lab analysis consistent with PINS findings
Sept. 1992	Rexburg, ID	DOT 500X ton container	PINS detected hydrocarbon fill; lab analysis showed actual fill was propane.
Dec. 1992	Naval Explosive Ordnance Disposal Technical Center Indian Head, MD	Navy cluster bomb	PINS detected no phosphorous, despite markings on the bomb which indicated nerve agent fill. Lab analysis determined the fill was ethylene glycol and water.
Jan. 1993	Washington D.C., Spring Valley neighborhood	66 World War I era munitions, including 75-mm artillery shells and 200-mm Livens projectors	PINS showed that about 25% contained CW agent fill; lab analysis of 9 items was 100% consistent with PINS findings. (See Table 7.†)
Feb. 1993	Redstone Arsenal, AL	2 M-55 rockets	PINS detected no phosphorous, ruling out nerve agent fill. Lab analysis showed the fill was hydraulic fluid.
May 1993	Dugway Proving Ground, UT	52 suspect chemical munitions	Dugway personnel explosively destroyed two armed projectiles, and via soil samples, determined their contents were consistent with PINS analysis results.
June 1993	Rigby, ID	suspect nitroglycerin bottle	PINS detected strong mercury peaks; contents later confirmed as mercury.
April 1994	Eglin AFB, FL	2 M-55 rockets	PINS detected no phosphorous, ruling out nerve agent fill. Lab analysis showed the fill was ethylene glycol and water.
May 1994	Washington D.C., Spring Valley neighborhood	World War I 200-mm Livens projector	PINS detected chemicals consistent with Bureau of Mines smoke mixture (See Table 8†); lab analysis confirmed results.
June 1994	Fort Lewis, WA	4.2-inch mortar projectile	No key elements were detected by PINS; fill determined to be non-toxic simulant.

†A.J. Caffrey, et.al, "U.S. Army Experience with the PINS Chemical Assay System," Idaho National Engineering Laboratory, U.S. Department of Energy, September 1994. Reprinted by permission.

Pins Report

Shown below is the PINS output report. A summary is supplied of the constituents which have been determined to be present.

PINS ANALYSIS v1.3

Analysis Setup Exit

Filename Window

Directory: [demo]

Filename: p3081704.chn

p2082009.chn
p2082202.chn
p2082203.chn
p2082410.chn
p3081704.chn
p3081708.chn
p3081803.chn
p3082113.chn
p3082409.chn

Result Window

Analysis of spectrum p3081704 done 08-SEP-94 15:51
" 155m H 1000 second count second shell"

Live Time: 1000
Autocal calibration

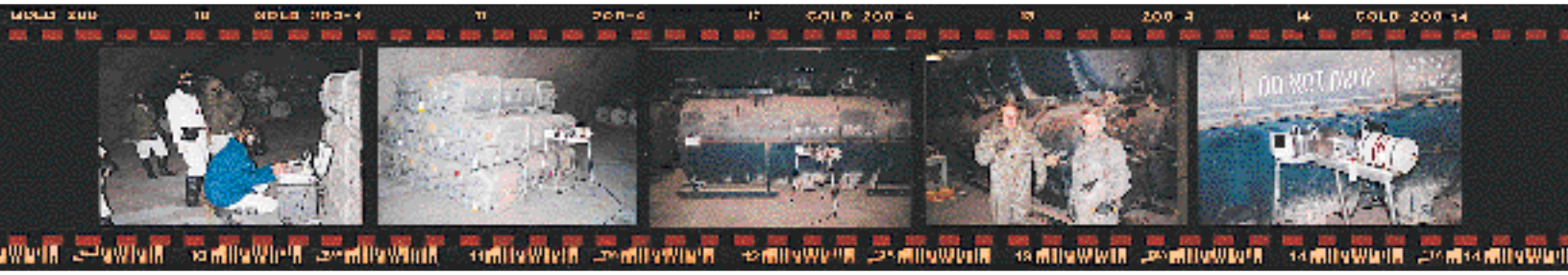
Detection Confidence (LOW – HIGH)

Cl	1.00
S	1.00
P	
N	
As	
Fe	1.00
H	1.00

Assay consistent with

H

mustard gas



System Components

The system comprises:

EG&G ORTEC High-Resolution Ge detector
NOMAD™ Plus Portable Spectrometer
Notebook computer
PINS software
Support table and shields
Neutron source (available separately)
Safety signs and tools
30-liter storage-fill dewar

Table 2. Equipment Inventory.

Box #	General Contents	Components
1.	Refill dewar with stand	30-liter storage-fill dewar with stand plate mounted Legs (3)
2.	Table equipment	Table top Leg set of 3 Long leg extension set of 3 Short leg extension set of 3 Detector slide adapter Bismuth collimator Polystyrene source holder Tungsten shield
3.	HPGe detector	Detector in cryostat with 1.2-liter dewar attached
4.	Instrumentation	NOMAD Plus system Computer Neutron survey meter Hard disk transport box
5.	Tools and accessories	Tool bag with hand tools Cable bag with NOMAD Plus cable Safety rope Safety signs (2) Extension power cord Safety equipment

Custom Fitted, Foam-Lined Polystyrene Boxes for all Components.

Supplies

PINS is a portable system. The NOMAD Plus portable spectrometer operates from internal batteries for 8 hours, or alternatively from a vehicle battery. The internal batteries may be recharged from the line.

The NOMAD Plus supplies power to the Ge detector; the latter, although totally portable in its "all attitude" 1.2-liter cryostat/dewar, must be refilled with liquid nitrogen every 18 hours.

The lifetime of the notebook computer without battery swap or recharge depends on the model chosen.

Weight

Total shipping weight: 280 kg (610 lbs).

Ordering Information

Model	Description	From
PINS-1	Complete PINS system MINUS neutron source, but including details of source (includes neutron monitor for radiation protection of personnel)	EG&G ORTEC
Model 100	Neutron Source, ^{252}Cf, 5 µg (±5%), in holder, ready to install (Requires appropriate license)	Frontier Technology Corporation P.O. Box 486 1641 Burnett Drive Xenia, OH 45385 U.S.A.
Model 50240	Source Shipping Container (5-gallon drum "pail")	Frontier Technology Corporation

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4172 0196

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